NASA's Land-Cover/Land Use Change Program: Landsat Activities

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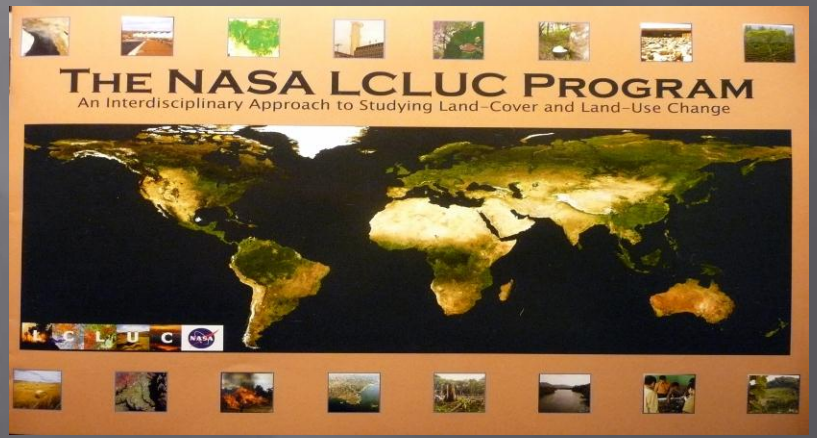
Land-Cover/Land-Use Change Program

- LCLUC is an interdisciplinary scientific theme within NASA's Earth Science program. The ultimate vision of this program is ***to develop the capability for periodic global inventories of land use and land cover from space, to develop the scientific understanding and models necessary to simulate the processes taking place, and to evaluate the consequences of observed and predicted changes***
  - http://lcluc.hq.nasa.gov/

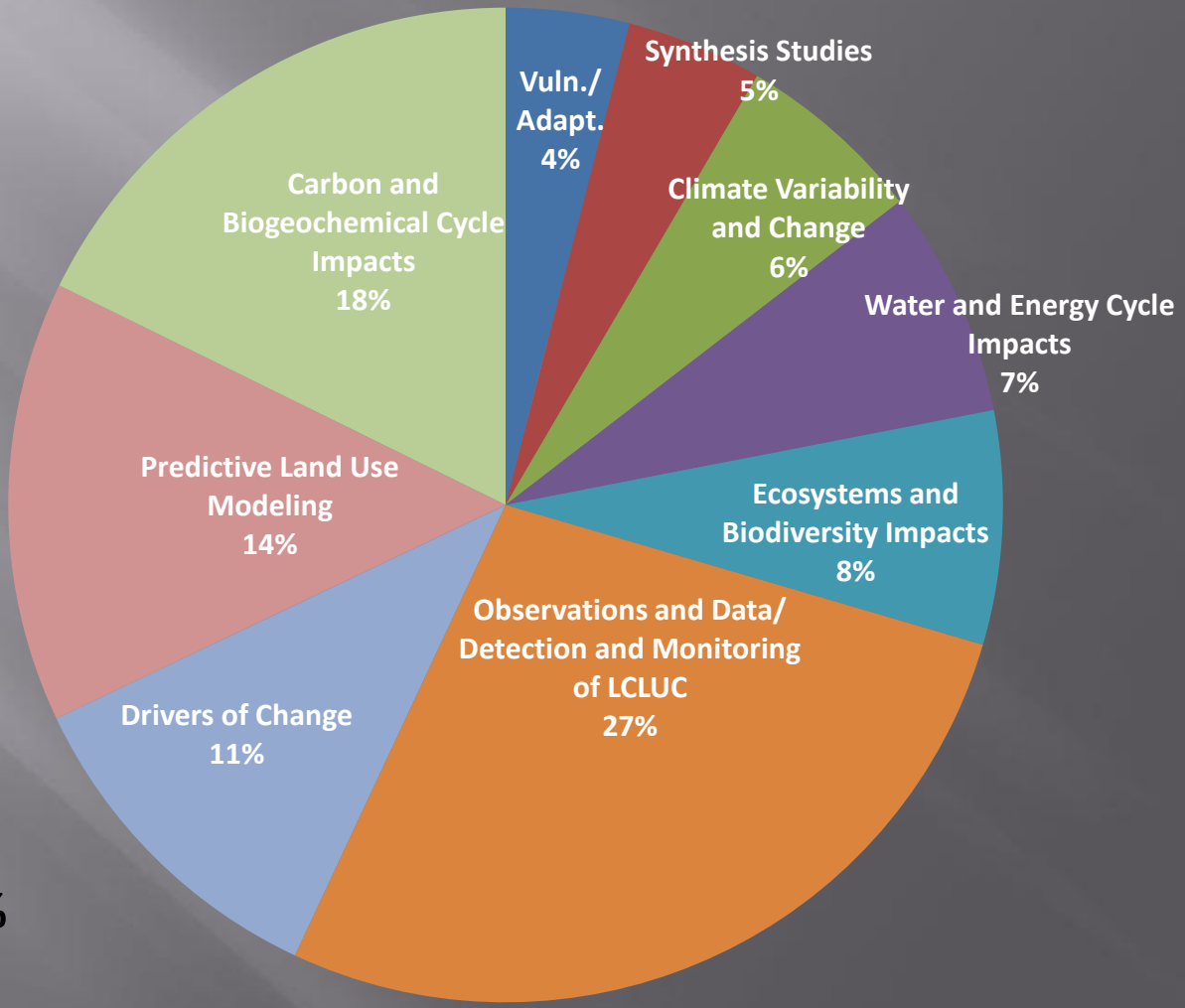


LCLUC Program: First 15 years 1997-2011

~ 200 projects during 15 years

~30-40 per year

~200 researchers per year



Impacts - 33%
Drivers – 11%
Monitoring – 27%
LU Modeling – 14%
LU <-> Climate - 6%
Synthesis – 5%
Vulnerability/Adaptation – 4%

LCLUC Current Portfolio

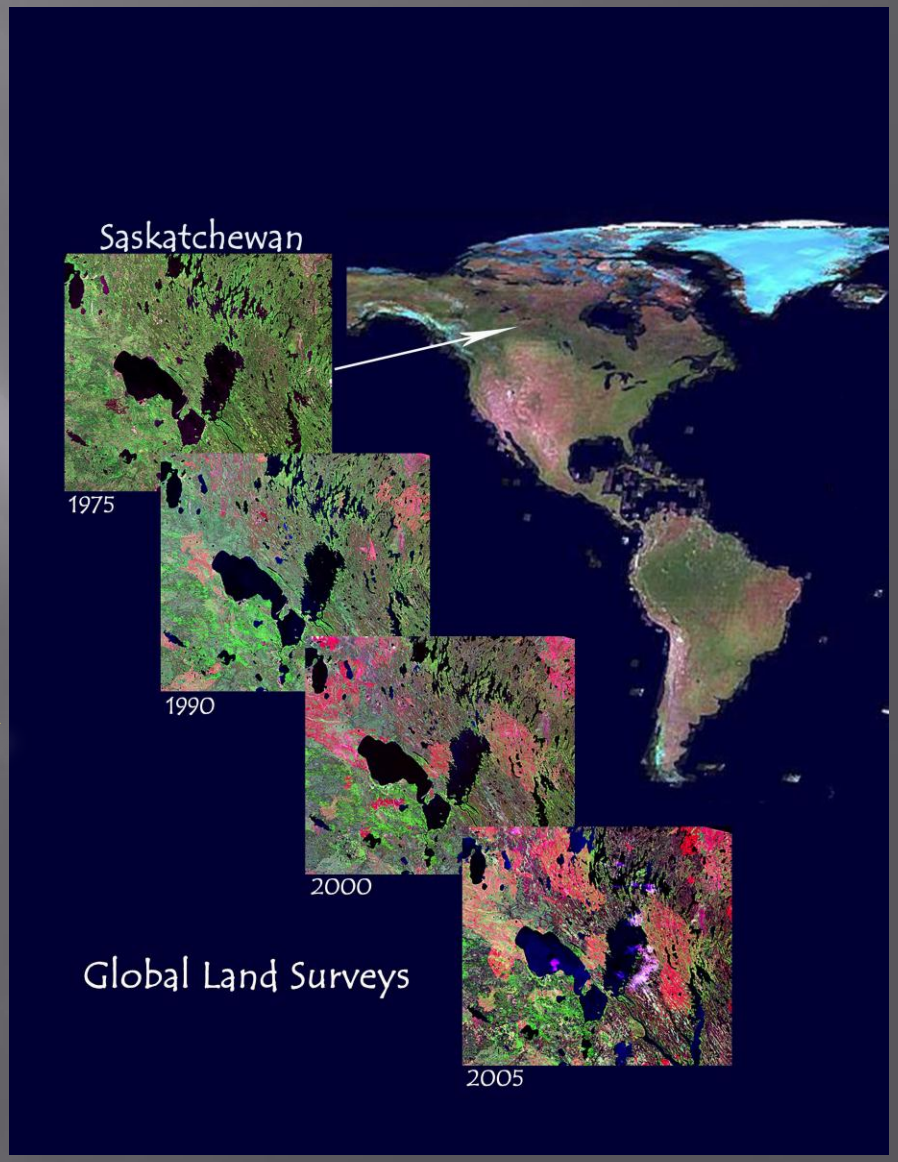
- ROSES-2007 5-yr mid-term
  - USPI
- ROSES-2008 final stage
  - LCLUC
- ROSES-2009 mid-term
  - LCLUC (Agriculture and Urban)
- ROSES-2010
  - USPI 5-yr mid-term
  - Carbon Cycle mid-term
  - LCLUC new starts (Synthesis and Wetlands)
- ROSES-2011 new starts
  - LCLUC Early Career Scientists
  - IDS Urban Impacts on Environment
- ROSES-2012
  - LCLUC Step-1 submitted (Industrial Forests Mapping and Synthesis)

Global Land Survey Data Sets

Global cloud-free, geocorrectedd Landsat datasets centered on 1975, 1990, 2000, 2005, and 2010

NASA-USGS Partnership

- 1 scene per epoch at the peak of vegetation
- 30-m global mosaic
- For global assessments of land-cover change
- Available at USGS archive
- Paper describing GLS-2005 published in P&RS Journal
- GLS datasets are complete and available for download via GLOVIS/EarthExplorer
- Paper on assessment of GLS datasets is under revision for publication in RSE Journal

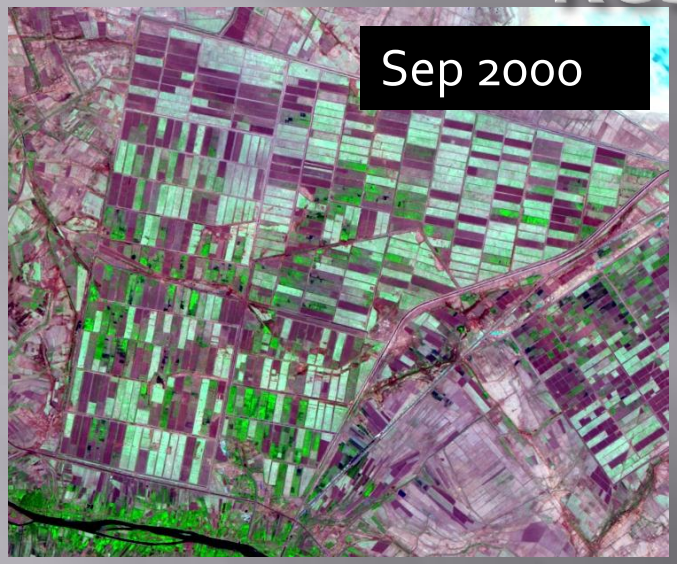


Progression of fires scars in central Canada

Advanced Use of Mid-resolution Data

- Fusing course- and mid-res data
- Using all cloud-free pixels in the imagery
- Fusing data from different mid-res sensors

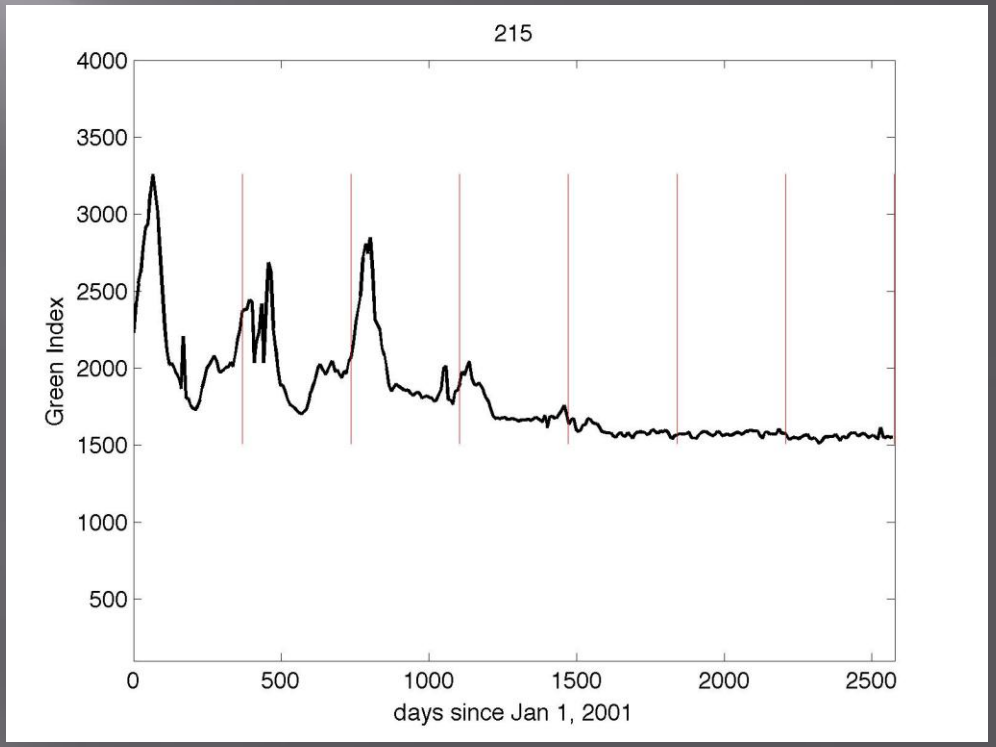
Changes in Land Use: Fusing Moderate and Coarse Resolutions



Landsat images for two periods

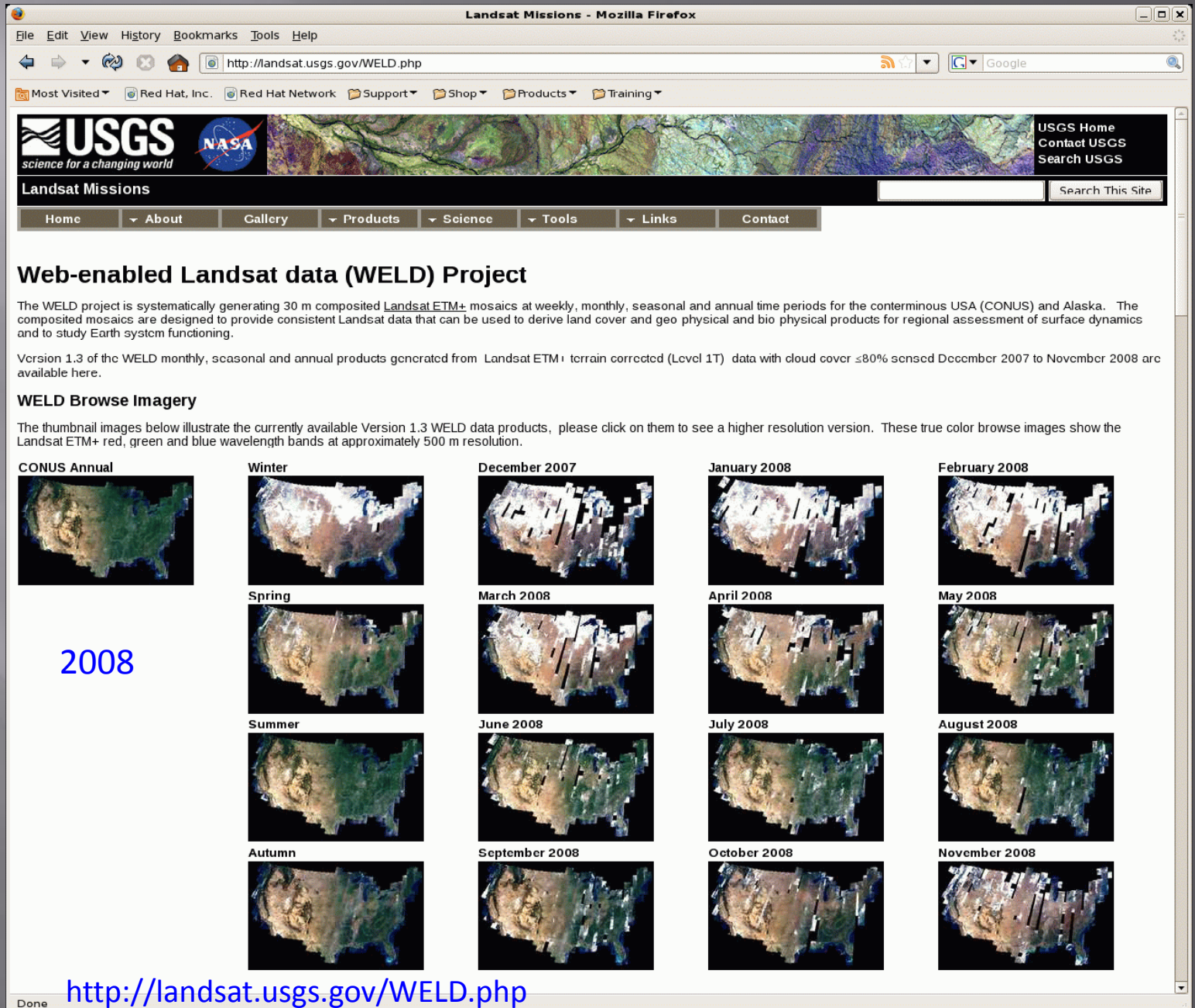
Iraq

MODIS time series of Green Index for an abandoned irrigated area

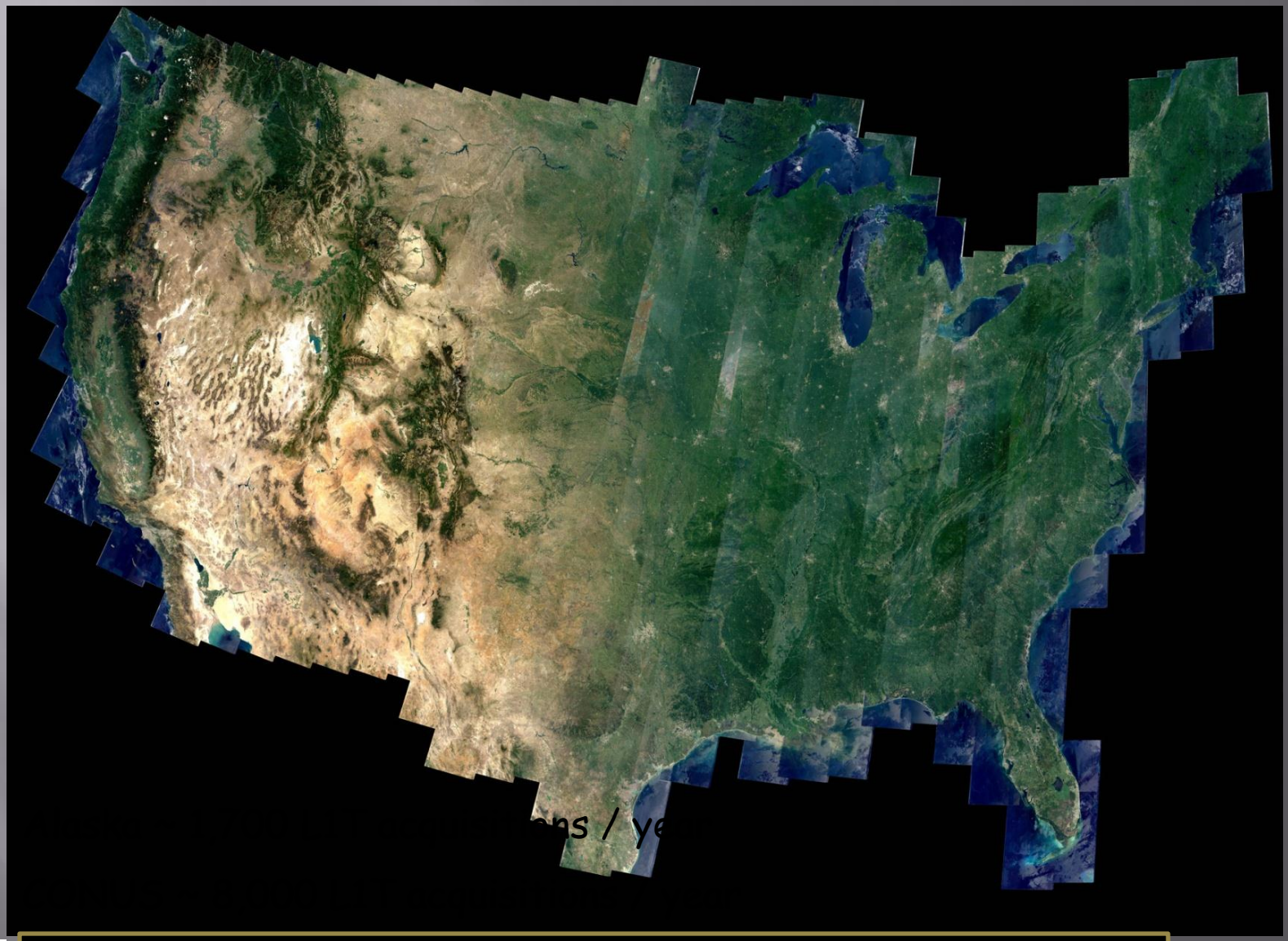


Annual, Seasonal, Monthly Composited Mosaics

Using
All Clear
Pixels by
Compositing



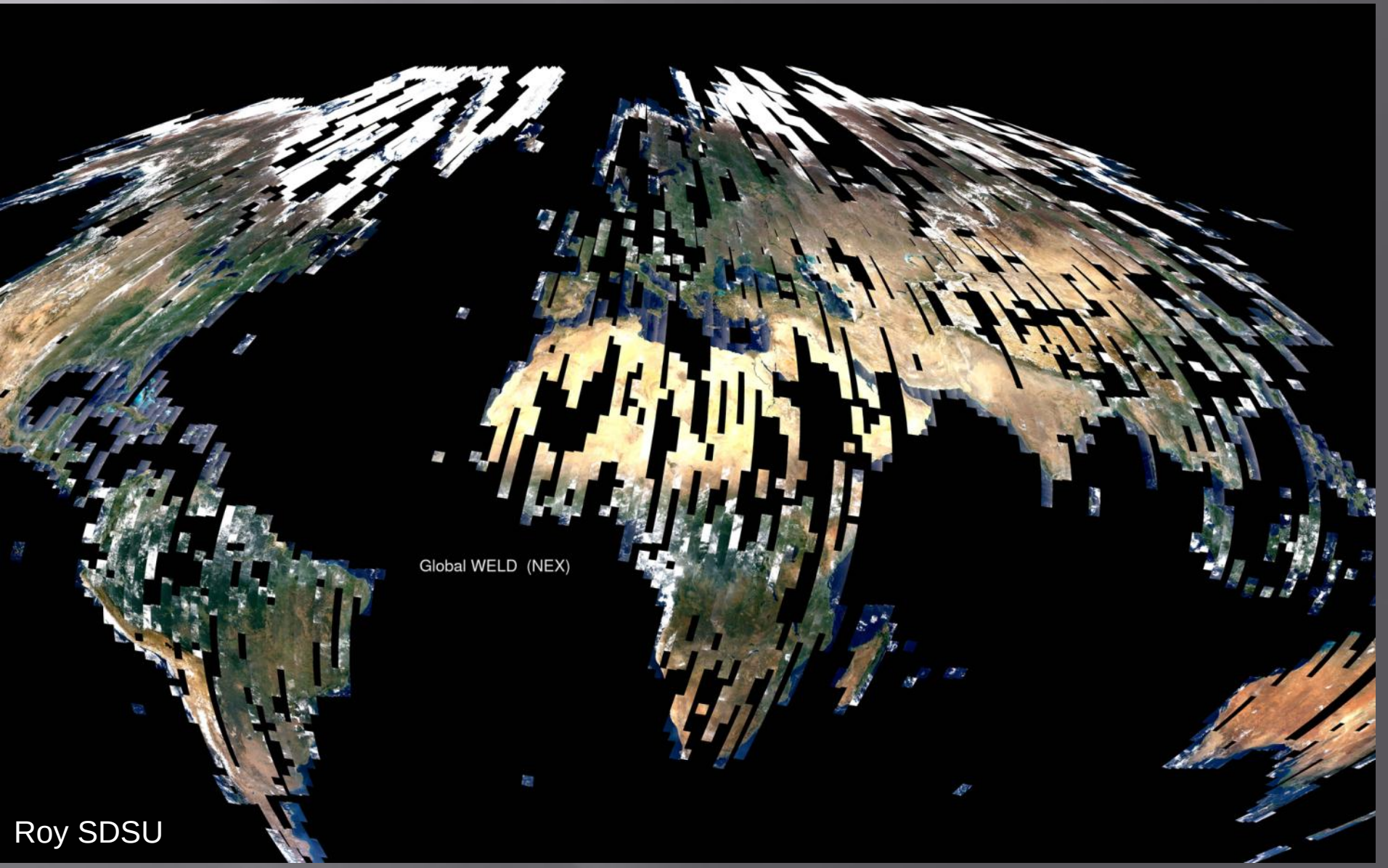
Web-Enabled Landsat Data (WELD). Year: 2009



New tools and methods to process large data volumes from Landsat

Roy SDSU

Global Landsat Processing Using High Performance Computing (7,281 input images, Monthly Composite May 2010)



Roy SDSU

1.8km TOA true color browse, each pixel generated from 60 x 60 30m Landsat ETM+ pixels MODIS Land Sinusoidal Projection

Agricultural Monitoring Needs

Agricultural monitoring has emerged as a key priority for GEO

• Global provisioning of food and water among most critical environmental issues in 21st century
• Maize (2008) and wheat (2010) supply constrictions caused global price spikes and food insecurity
• G20 Ag ministers requested creation of GEO-GLAM (Global Agricultural Monitoring initiative); ratified by CEOS (2011).

Crop assessments (type, condition) require ~weekly data @ <50m resolution

Currently no single remote sensing system satisfies this requirement

•MODIS & MERIS can provide weekly phenology but at regional scales
•Landsat can resolve individual fields, but only seasonally

Hillsides in the Nilgiris being prepared for planting vegetables, shot by Rafeek Manchayil,

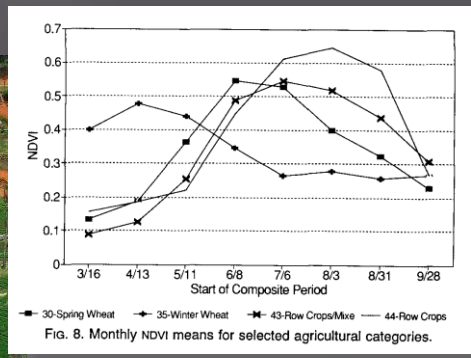
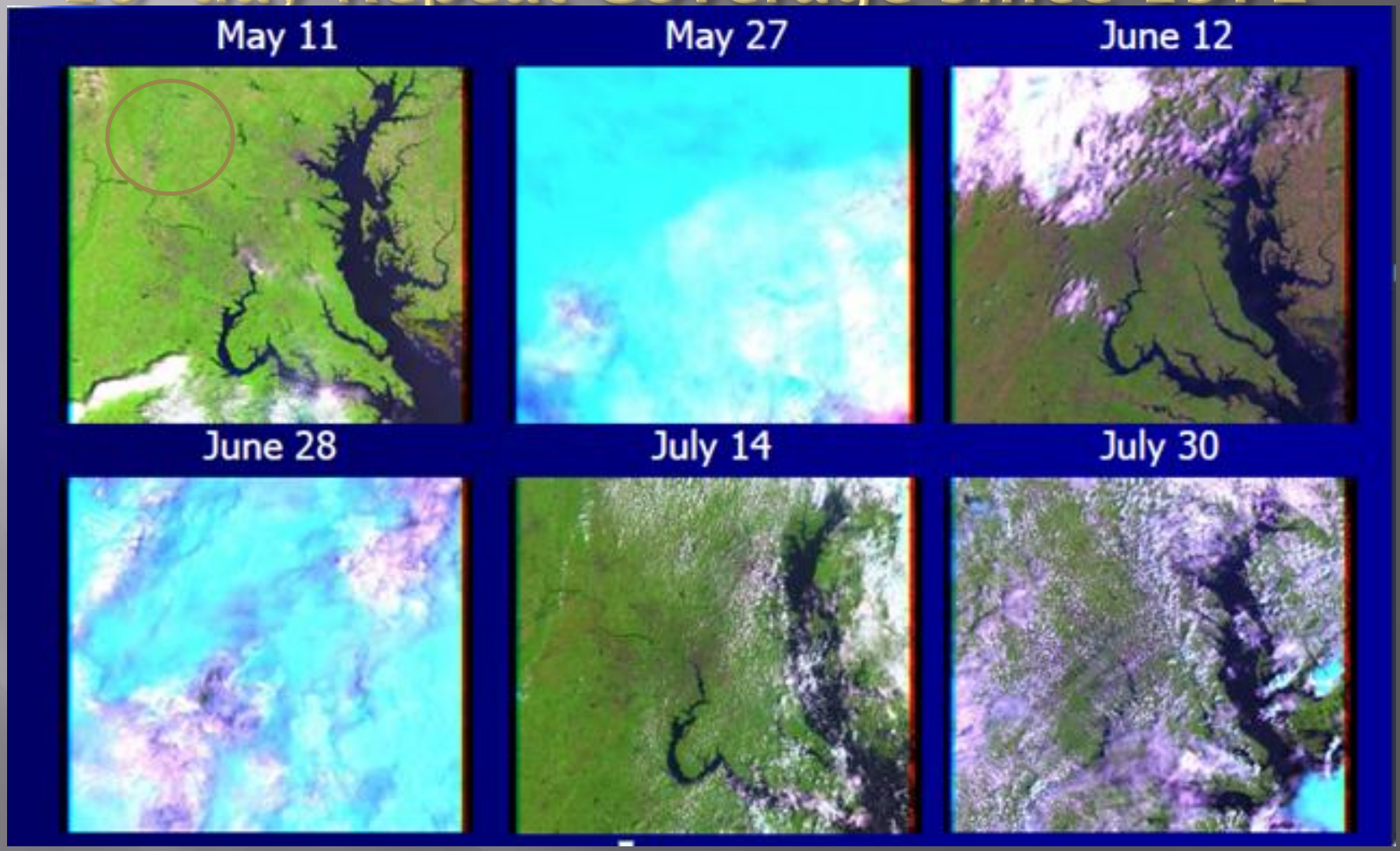


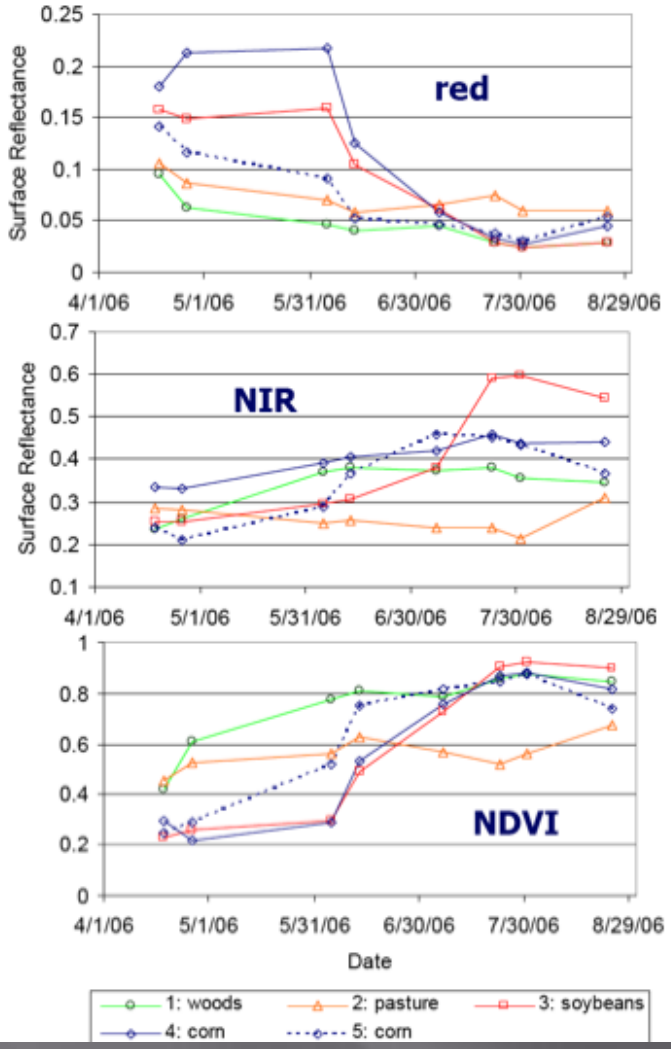
FIG. 8. Monthly NDVI means for selected agricultural categories.

Single Landsat:
16-day Repeat Coverage since 1972



More frequent imaging is needed to maximize opportunity for cloud free observations particularly for rapidly changing phenomena: Fire, Flooding, Agriculture

Fusing data from landsat-like sensors: Land-cover phenology at 30 m

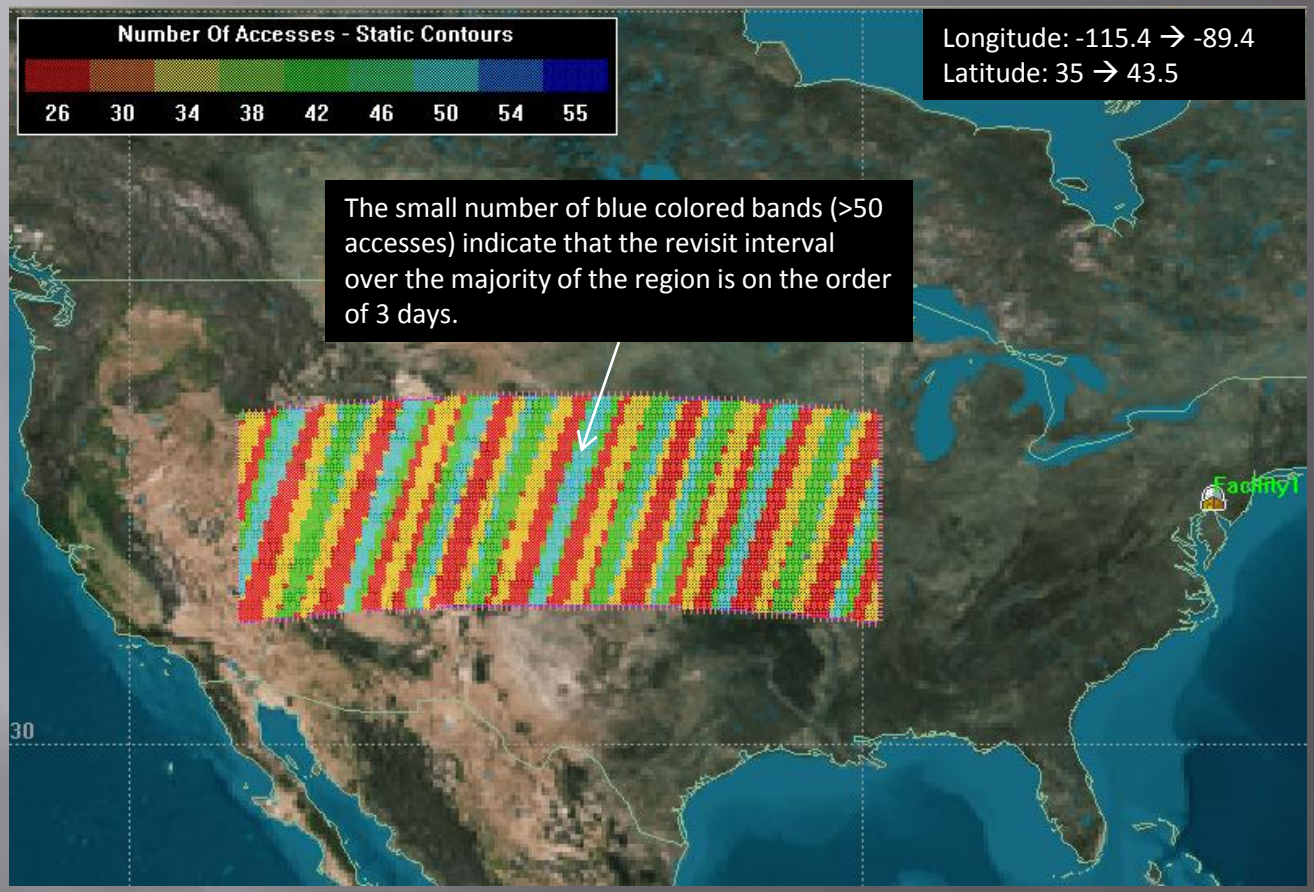


- **Red reflectance, near-infrared (NIR) reflectance, and NDVI values for individual fields from central Illinois during the first half of the 2006 growing season**

- **Data are combined from Landsat-5, -7, ASTER, and IRS**

Courtesy of Feng Gao, ARC/USDA

Sentinel 2a,b – Landsat 7, 8: U.S.

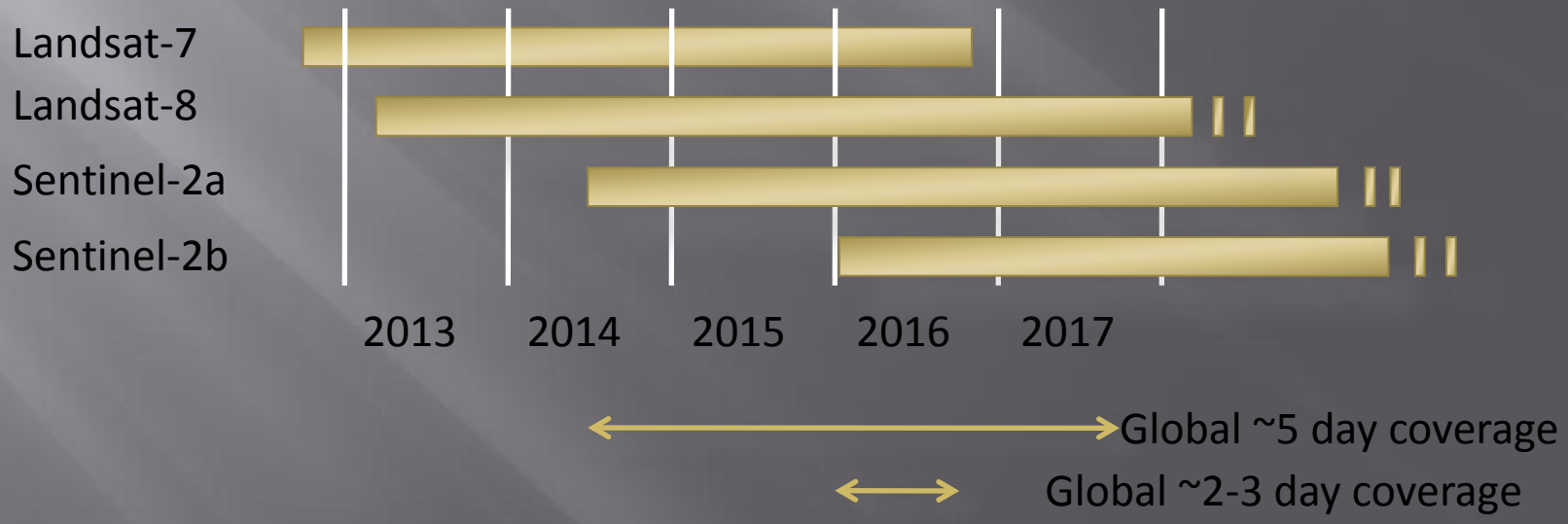


- The picture shows the number of times the sensors for the Sentinel 2s, Landsat, and LDCM accessed areas on the ground over an 80 day period of time.
  - 26 accesses indicates a maximum revisit interval of ~3 days 2 hours
  - 55 accesses indicates a minimum revisit interval of ~1 day 11 hours

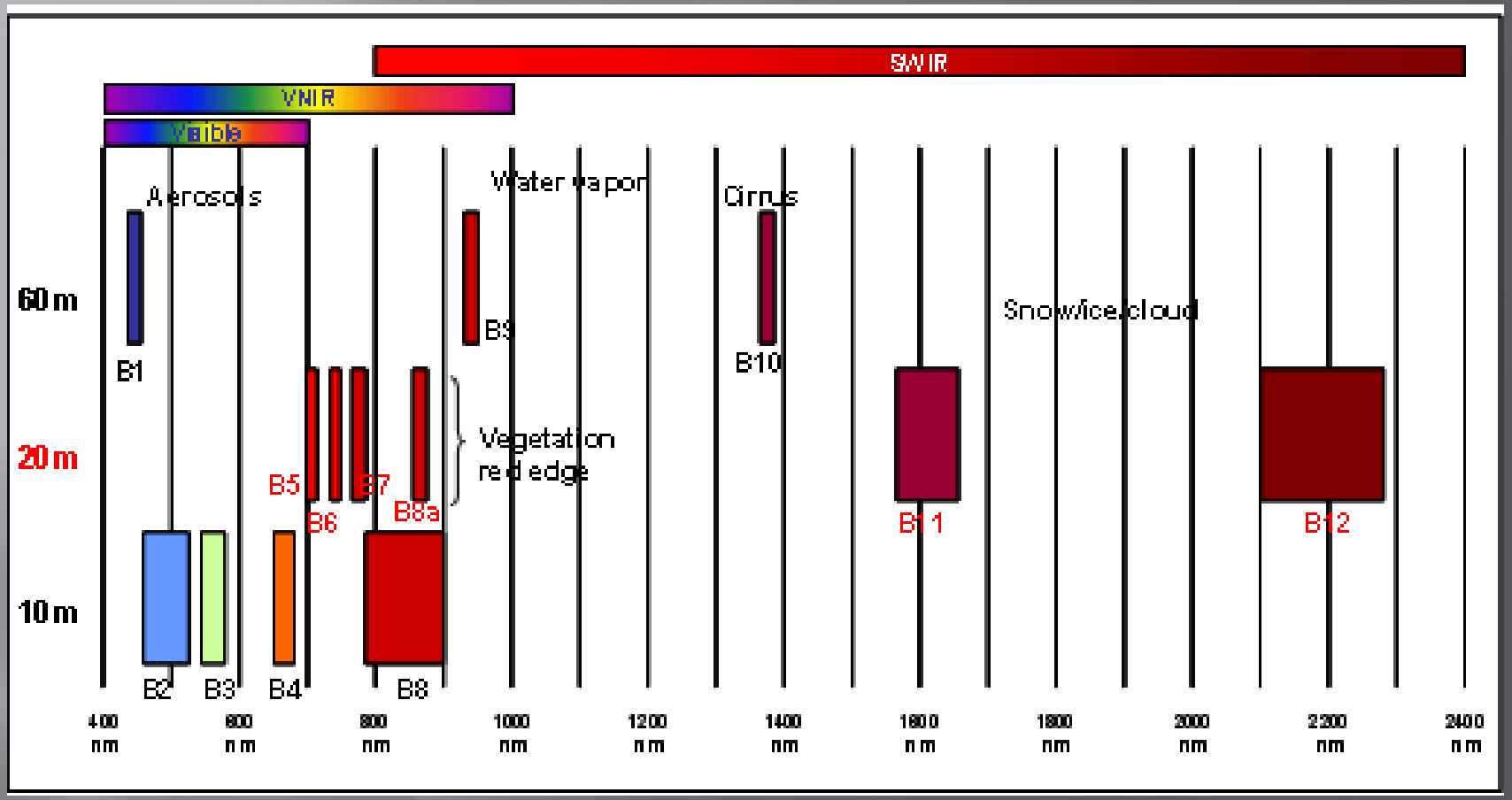
Sentinel-2 and Landsat Fusion

Merging Sentinel-2 and Landsat data streams could provide < 5-day coverage required for Ag monitoring

- Both sensors have 10-30m coverage in VNIR-SWIR
- Satellite orbits complementary
  - Landsat-7 & Landsat-8 8 days out of phase
  - Sentinel-2a & 2b 5 days out of phase
  - Landsat and Sentinel-2 sun synch orbits precess relative to each other



Sentinel-2 Bands



- 2 satellites (Sentinel 2a and 2b)
- 290 km swath width
- 7-year design life
- Polar, sun-synchronous orbit (precessing relative to Landsat)

L-8 OLI vs S-2 MSI: Spectral Bands (nm)

Sentinel-2 MSI Bands			Landsat-8 OLI Bands		
Band 1	**60 m Coastal/Aerosol**	0.433 - 0.453	**30 m Coastal/Aerosol**	0.433 - 0.453	**Band 1**
Band 2	**10 m Blue**	0.458 – 0.523	**30 m Blue**	0.450 - 0.515	**Band 2**
Band 3	**10 m Green**	0.560 - 0.595	**30 m Green**	0.525 - 0.600	**Band 3**
Band 4	**10 m Red**	0.650 - 0.680	**30 m Red**	0.630 - 0.680	**Band 4**
Band 8	**10 m Near-IR**	0.784 – 0.899	**30 m Near-IR**	0.845 - 0.885	**Band 5**
Band 11	**20 m SWIR-1**	1.565 – 1.655	**30 m SWIR-1**	1.560 - 1.660	**Band 6**
Band 5,6,7, 8a	20 m Red edge bands		**100 m** **100 m**	10.30 –11.30 11.50 –12.50	**Band 10** **Band 11**
Band 12	**20 m SWIR-2**	2.100 – 2.280	**30 m SWIR-2**	2.100 - 2.300	**Band 7**
Band 9	60 m water vapor correct	0.935-0.955	**15 m Pan**	0.500 - 0.680	**Band 8**
Band 10	**60 m Cirrus**	1.365 - 1.395	**30 m Cirrus**	1.360 - 1.390	**Band 9**

* Cirrus Band added in 2001 to detect cirrus contamination in other channels
- Coastal Band added in 2001 at request of ocean color investigators requiring higher resolution of coastal waters relative to MODIS and SEAWifs
- Bandwidth refinements made in all bands to avoid atmospheric absorption features
- Push-broom instrument architecture yields higher SNR
- LDCM TIRS is a two band instrument => will enable atmospheric correction for a more accurate surface temperatures derivation for 100-m thermal images as compared to a single thermal band on Landsat-7 ETM+ but with 60-m resolution

SUMMARY

- Landsat is a critical tool for Earth Systems Science in quantifying and understanding global LCLUC
- The Landsat data record must be continued beyond Landsat 8 – what happens if Landsat 8 goes the way of Landsat 6 !
- Nobody questions why we need operational weather satellites - we need a similar 'operational' status for Landsat observations – with reduced mission costs and increasing the number of instruments flying/ready to fly
- Need to incorporate Landsat-like data from non-US sensors, such as Sentinel-2 and other (CBERS, IRS, etc.)
- The next Landsat (-8) in tandem with Sentinel-2 would be a good step towards the CEOS constellation paradigm
- We need to continue to develop smart, automated tools to exploit the large volume, time-series of Landsat data

Thank You,
To be Continued by Jeff Masek